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Middle Ear Operations

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MIDDLE EAR OPERATIONS.

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From the time of Sir Astley Cooper's perforation of the membrana tympani, for the purpose of relieving deafness and subjective noises, and with a view to the maintenance of a permanent opening, the surgical treatment of diseases of the middle ear has had a definitely progressive history.

It is a notable fact that the first persistent efforts at surgical treatment of the middle ear, including the removal of a portion of its tissues, was made with the intention of improving the hearing and not for the accomplishment of a purpose more directly in the line of a surgical procedure in the removal of diseased tissue consequent upon a suppurative process.

Based upon a comparatively imperfect anatomical and physiological knowledge, and dealing only with the more superficial part of the sound-transmitting apparatus, the simple myringotomy and myringectomy, as well as the trepanation of the mastoid, for the relief of deafness and subjective noises, fell into a deserved desuetude.

With an increase in the knowledge of the structure and functions of the middle ear, and with the impulse given to the investigation of this minutely interesting field for pathological research, came a better appreciation of the importance of surgical interference in cases of suppurative middle ear disease, including not only the use of means and measures for thorough cleansing and efficient drainage, but also for surgical procedures for the purpose either of



removing necrotic, or even healthy, tissue, if the latter served to retain morbid secretion or interfered with access to a diseased part.

These operations included, of necessity, the division of obstructive folds and adhesions in the middle ear, the use of the curette upon the bony walls of the tympanic cavity, the removal of the two larger ossicula, when diseased, or even when healthy if they proved obstructive, and, in addition, for the purpose of gaining better access to the fornix tympani, the removal of the upper and inner end of osseous canal. The observed cases of spontaneous evulsion of the malleus and incus, the stapes remaining in situ, and a consideration of the space occupied by the heads of these bones in that portion of the fornix tympani most subject to persistent suppurative disease, and their special liability, on account of their internal structure and nutrition, to become the seats of a necrotic process, are all in favor of their removal, under proper surgical indications. But the removal of the larger ossicula in cases of non-suppurative diseases of the middle ear and for the purpose for which Sir Astley Cooper perforated the membrana tympani, is entirely another question.

The improvement which has been effected in the cases of this kind already reported, is apparently due to two causes: namely, the relief afforded to the stapes by the removal of parts which, under conditions of disease, have come to interfere with its mobility, and, furthermore, the mobilization of the stapes itself incident to the operative interference.

Briefly put, so far as operation is concerned in suppurative disease where any interference with the ossicula is demanded, it is the removal of the incus, malleus, or malleus and incus, which is generally important.

In the chronic non-suppurative disease of the middle ear, however, where surgical interference is determined

upon on account of anchylosis, adhesions, general thickening of the tympanic membrane, or other obstruction to the sound transmission through the ossicular chain, the removal of the malleus or incus may be considered either merely as incidental or as superfluous,—possibly, even as an unnecessary violence, since it is really the *stapes* that holds the key to the situation.

Experience in the surgical treatment of chronic suppurative disease of the middle ear, and the consequent appreciation of the extent to which the structures in that cavity may be safely interfered with, has gradually led to the consideration of the surgical invasion of this cavity in chronic non-suppurative disease, with a view to effecting an improvement in the hearing.

The surgery of the middle ear in this respect has, therefore, swung around a circle, but as all advance is in the form of a spiral, the objective point is no longer the *membrana tympani*, but, instead, the *stapes*, the termination—further end—of the sound-transmitting apparatus.

The experiments of Kessel,¹ made very nearly twenty years ago and based upon carefully considered theoretical grounds, showed that the removal of the *columella* in birds could be effected without disturbance of co-ordination, and even where there was rupture of the basal membrane and exudation of *peri-lymph*, without permanent impairment of hearing, while his experiments on mobilization of the *stapes* in the human subject showed that considerable force could be exercised upon that bone without producing other than a temporary labyrinthine effect.

Since the first communication of Kessel, various procedures² for the mobilization of the *stapes* have been proposed and practiced, especially in cases of immobility of that ossicle as a consequence of suppurative disease of the

¹ *Archiv für Ohrenheilkunde*, Vol. XI., p. 199.

² Schwarze, Urbantschitch, Miot, Gellé.

middle ear. These have ranged from mechanical and auto-massage to the division of adhesions, tenotomy of the stapedius muscle, and "circumcision" of the stapes as practiced by Kessel, in the case operated upon by him in 1875.

But the question of the removal of the stapes itself has, until recently, been left out of serious consideration.

Various suggestions as to the possibility of this as a justifiable procedure have, from time to time, appeared in the literature of the subject, including mention of the accidental or intentional removal of the stapes in individual cases, but there has been no definitely planned series of clinical observations extending over a sufficient period to furnish that sound basis of conclusion by which such a question could be judged, or on which so important an addition to our means of treatment of a certain class of apparently hopeless cases could be based; and it had been my intention in continuance of previous observations to avail of the material afforded by the aural clinic of the Massachusetts Charitable Eye and Ear Infirmary during the spring term, April, May, and June of this year, for that purpose; but a temporary loss of the use of the right hand obliged me to place the greater part of the operative work of the clinic, in the hands of the assistant aural surgeon then on duty, who thus had an opportunity to practically demonstrate the feasibility of the operation of stapedectomy on the human subject in a larger number of cases than has as yet been anywhere recorded. These operations done by Dr. F. L. Jack were carried out with valuable advice and suggestions from Dr. William S. Bryant, aural clinical assistant, and, with the addition of subsequent observation of the individual cases, will furnish a valuable contribution to our practical knowledge of this subject.

The rational sequence of a definitely planned series of clinical observations, in cases where the fixation of the stapes is the result of thickening and adhesions consequent

upon suppurative disease, and where there is an existent perforation of the membrana tympani, would naturally be, firstly, separation of the stapes from the incus, if the latter bone remains in place, tenotomy of the stapedius muscle, and division of adhesions in the niche, and, as a consequent, or as a subsequent, procedure, the removal of the stapes itself.

Secondarily to this, there would be the application of the same course of procedures to those cases of a high grade of deafness due to the fixation of the stapes, with or without a similar condition in the remainder of the ossicular chain, as the result of chronic *non-suppurative* disease of the middle ear.

The first step in this latter direction, historically considered, was made in the original attempt to maintain a permanent opening in the membrana tympani, which should allow the sound waves passing the obstructive portion of the ossicular chain to fall upon the base plate of the stapes and so set it in vibration.

The next step was the bolder one of Kessel's later suggestion, the success of which as a surgical procedure has been demonstrated in this country, and which included the removal, not only of the membrana tympani, but also of the two larger elements of the ossicular chain, thus, not only allowing the sound waves to fall upon the stapes directly, but also of relieving that bone of the super-incumbent weight and immobilizing effect of the larger ossicles; while the third step consists in the removal of the stapes itself.

The justifiability of this latter operation is to be premised from the fact that the stapes, situated as it is in its niche, is especially liable to be tied down by the thickening of those reduplications of the mucous membrane which are found in about eighty per cent. of normal ears between the posterior crus of the stapes and the correspond-

ing wall of the stapedial niche, extending usually from the tendon of the stapedius downward, and sometimes upward and forward, and from the fact that the removal of this bone, with all its possibilities of obstruction, allows the sound waves to fall directly upon a membrane which will, thus unhindered, respond more readily to sonorous vibrations; and to the further fact, that this operation has been performed without injury and with more or less permanently good results.

Theoretically, in cases of non-suppurative disease of the middle ear with a high grade of deafness due to fixation of the sound-transmitting apparatus, and with good hearing by bone conductions, the removal of the membrana tympani and the whole of the ossicular chain would leave in the oval window a membrane in its condition more nearly corresponding, for response to vibrations, to that of the round window than would have been the case if the stapes had been left in place. Practically, this has been proven by the improvement in hearing which has followed the removal of the stapes.

My own experience in this matter includes a series of experiments in various cases, beginning with the observations having reference to diagnostic value of high musical tones¹ extending up to the present time and including operations in the following sequence: (1) Excision of the posterior segment of the membrana tympani, allowing the sound waves to fall directly upon the stapes. (2) Formation of a flap from the posterior segment of the membrana tympani and attachment of it to the descending process of the incus for the purpose of transmitting the vibrations of the membrane directly to that bone. (3) Division of the incudo-stapedal articulation through a small triangular opening in the membrana tympani. (4) Attachment of a flap from the posterior segment of

¹Diagnostic value of high musical tones.—C. J. Blake, 1873.

the membrana tympani to the head of the stapes, the incus being either wanting or removed. (5) Division of the incudo-stapedal articulation, in cases of existing perforation of the membrana tympani, division of the stapedius muscle and of mucous folds or adhesion. (6) Removal of the stapes itself.

The one case which, perhaps, best illustrates the results of this latter procedure, because of the time which has elapsed since the operation, is that of a young man first seen in 1875, who was at that time ten years of age, and who had in both ears a suppurative process following scarlet fever.

In the right ear there was a large perforation in the posterior portion of the membrana tympani, the incus was wanting, and the stapedal niche was filled by a mass of tough granulation tissue; the hearing was much impaired, but was better for loud sounds of high pitch than for voice sounds of corresponding intensity.

The hearing for a tuning-fork (562 v. s.) was better by bone conduction than aerially. Thorough cleansing of the ear and cauterization of the granulations improved the hearing, but as the growth recurred with persistence, entire clearing of the oval niche was decided upon and effected by means of a wire snare and curved forceps; the result, in addition to the decrease of the secretion, which at this time came principally from this redundant growth,—the remaining portion of the middle ear being nearly dry,—was a marked improvement in the hearing, which increased with a subsidence of the remaining granulation tissue in the niche and has continued up to the time of the last observation of the case made, June 29, 1892, at which time the right ear was found to be perfectly dry, as it had been for several years, with an existing perforation of the membrana tympani, including the greater portion of the posterior segment, the lower end of the malleus adherent

to the inner tympanic wall, the round window free from encompassing adhesions, and the oval niche, which in this case was fortunately plainly visible, showing at its bottom the clear and shining membrane of the fenestra ovalis.

The left ear being tightly stopped, the hearing in the right ear was found to be, for the Politzer's acoumeter, 180 inches, for the tuning-fork (512 v. s.) 45/65 duration, the same fork being heard better aurally in the right ear, and better by bone conduction in the left ear, with both ears unstopped. König's rods were heard up to 40,000 v. s. in the right ear, and the voice in ordinary conversational tone at a distance of not less than fifteen feet.

Incidentally to the operation, it should be mentioned that the disturbance of the stapes was accompanied by marked but transient vertigo and a decided slowing of the pulse.

A review of the opinions expressed by the writers on this subject previously mentioned, and the results of personal experience thus far, lead to the conclusion that mobilization of the stapes, including stapedo-tenotomy and division of adhesions, are of value in cases the result of suppurative disease, where the mobility of the ossicle may be maintained either by occasional after-treatment or automatically, by making it the point of touch of an artificial membrane; and that the same procedure, surgical mobilization, is of comparatively little value in the chronic non-suppurative disease of the middle ear, either when the attempt is made to secure also a permanent opening in the membrana tympani, or to connect the stapes with the membrana tympani either by flap or cicatrix; and, therefore, of the surgical operations proposed for the improvement of hearing and the relief of tinnitus in severe cases of chronic non-suppurative diseases of the middle ear, the disarticulation and removal of the stapes, although it seems the more heroic procedure, is one likely to be of

more lasting benefit than the removal of the incus, or malleus and incus, or than merely tentative efforts at mobilization. Indeed, I should not, in the light of present experience, hesitate to recommend stapedectomy in cases where I had previously proposed dividing the articulation of the incus and stapes and division of the tendon of the stapedius muscle.

Of the operations of disarticulation and stapedo-tenotomy, or of stapedectomy itself, it may be briefly said that these vary very much in difficulty in individual cases, in reference to the position of the oval window and its relation upward or downward to the posterior-superior periphery of the membrana tympani; and that, all anatomical conditions being equal, the removal of the stapes is more easily effected in the chronic non-suppurative cases, than in those in which the fixation of the stapes is an incident of a long continued suppurative process.

The preliminaries to the operation in both the suppurative and non-suppurative cases should be the thorough cleansing of the ear with an antiseptic solution, by means of a cotton-tipped probe, syringing, especially in the latter class of cases, being avoided on account of the congestion which it causes.

The instruments, few in number, but of each of which there should be a duplicate, should be dipped in a solution of boracic acid and alcohol before using; there should be a number of cotton sticks at hand, and a weak solution of bicarbonate of soda may be provided in which to dip the instruments after using.

After the incision of the membrana tympani, which may be done according to the rule laid down by Miot, or by a triangular cut, the incudo-stapedal articulation should be divided by means of the angular knife, the principal cutting being done from behind forward, the pressure in this

direction being made against the pull of the stapedius muscle.

The tendon of the stapedius muscle may be next divided, and the straight knife used for that purpose also passed around the niche of the stapes, in order to divide any adhesions: the stapes may then be extracted either by means of the hook forceps, curved forceps, or by a blunt hook passed beneath the head of the stapes between the crura.

Traction should be made gently at first and accompanied by slight lateral movement to begin with, the bone where it comes away intact being finally lifted from its attachment with a sense of suction resistance, and usually without other evidence of reflex disturbance, if the patient is under ether, than the slowing of the pulse already mentioned and, possibly, a slight contraction of the upper extremities.

The removal of the incus in these cases is principally a question of its interference in the field of operation, its extraction being best effected after the division of the incudo-stapedal articulation and tenotomy of the stapedius muscle, by the use of the wire snare, stout curved forceps, or the hooked extractors of Ludewig, Ferrer, or some similar instrument. The removal of the incus under the conditions above mentioned is much more readily effected than when it has been preceded by the removal of the malleus, forcible extraction of the latter bone making a traction upon the fan-shaped posterior ligament of the incus which sometimes results, when the tension is relieved, in throwing the bone upward and backward into the comparatively inaccessible regions of the fornix tympani, and aditus ad antrum mastoideum.

After the operation, the field should be cleansed by means of dry absorbent cotton, and the ear tightly stopped with a cotton tampon which may be left in position for two or three days.

In the suppurative cases, the tampon should be removed within twenty-four hours after the operation, and the ear appropriately cleansed.

A consideration of the anatomy of the incudo-stapedal and stapedo-fenestral articulations shows that the operation of stapedectomy may be performed without that danger to the integrity of the labyrinth which has been so much dreaded as to prove a deterrent from the practical demonstration of its possibility; while the demonstration upon animals, and accidentally upon the human subject, of the fact that rupture of the basal fenestral membrane and outflow of peri-lymph is not of necessity fatal to the hearing, gives a still further assurance of safety.

The investigations of Rüdinger, Soemmering, Hueschke, Weber, Meckel, Eysell, Henle, and others, suggest in the adjustment of the base plate of the stapes in the oval window an arrangement somewhat analogous to that of the union of the malleus and the membrana tympani, the existence of a ligamentum orbiculare baseos stapedis, and of a distinct basal membrane, which conditions would permit of a direct removal of the stapes, with rupture of its superficial annular ligament, and without corresponding rupture, necessarily, of the basal membrane beneath it.

Another anatomical point of importance in this connection is the insertion of the tendon of the musculus stapedius, which, as has been shown by Rüdinger, is attached not only to the head of the stapes but also to the lenticular bone and, sometimes, also to the tip of the descending process of the incus; thus supplementing on its posterior side the capsular ligament of the incudo-stapedal articulation.

As differential diagnosis is the necessary prelude to successful surgical procedure, a definite opinion as to the value of stapedectomy can be arrived at only through the experience of a number of individual observers, and the investigation must of necessity include further study of the

stapedal articulation, both anatomically and pathologically, on the one hand, and on the other, careful record of the hearing power both immediately before and for a long time after the operation.

